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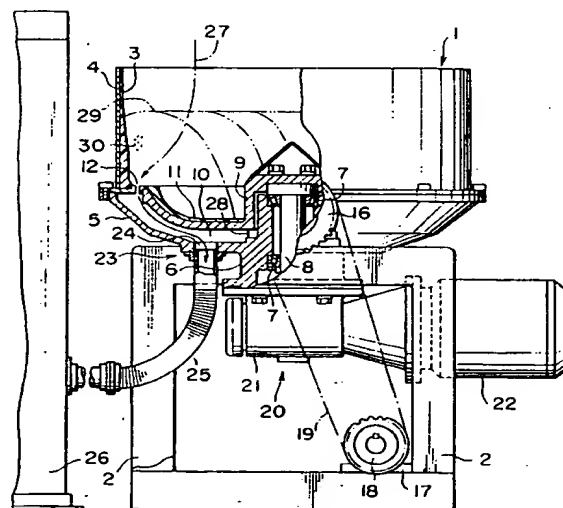
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(54) **Dry barrel finishing machine.**

(57) An improved dry barrel finishing machine in which a mass consisting of media (30) and workpieces is caused to flow in the barrel (1) of the machine for abrasive finishing of the workpieces and in which air suction is used to remove dust resulting from the finishing operation and to cool the barrel and the mass. The mass is caused to flow by rotation of the barrel by a motor (22) or through the vibration of the barrel by a driving mechanism (40;61). Air outlets (12,24) are provided in the barrel. An air suction device (23) draws air through the barrel and around the workpieces and media during the finishing operation. The drawn out air picks up dust and media particles resulting from the abrasive finishing operation and cools the media and the barrel.

FIG. 1



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This invention relates to a dry barrel finishing machine and a method of dry barrel finishing, wherein finishing media and workpieces are caused to flow in the barrel of the machine for fine abrasive finishing of the workpieces.

Generally, barrel finishing is well known as a method for finely grinding workpieces such as bolts, shafts, bearings, etc. In barrel finishing, a mass, which is comprised of finishing media and workpieces, is charged into a receptacle, i.e. a barrel, and the barrel is activated to cause the mass to flow in it so as to finish the workpieces through interactive attrition between the workpieces and the media.

Barrel finishing includes dry finishing and wet finishing. Wet finishing uses compounds and water as well as finishing media, while dry finishing does not use fluid. Wet barrel finishing requires washing and drying of the workpieces after the finishing, as well as water treatment for removing waste attrition fluid and waste washing water. It is well known that a drawback of wet barrel finishing is that it requires a drying apparatus and a fluid treatment device, and therefore it requires more space for these items. Another drawback is that wet barrel finishing takes additional time and labor.

In view of such drawbacks, dry barrel finishing is often used. In dry barrel finishing, however, attrition produces dust and fragments of the media. Further, frictional heat is generated due to the attrition between the workpieces and the media, and between the barrel and the mass. The attrition dust tends to spread out of the barrel and contaminate the environment. The dust also causes clogging in the media, thereby lowering the abrasive ability of the media and resulting in uneven finishing on the workpieces. Further, in a conventional centrifugal barrel finishing machine, which has an upper stationary tank and a bottom rotary disc, fragments of the media tend to get caught in the space or slit between the rotary disc and the stationary tank. If any fragment becomes jammed in the slit, the rotating disc and the tank are heavily rubbed thereby, and a frictional heat of high temperature will be generated. This heat tends to melt any liners covering the surfaces of the disc and the tank, and as a result, fragments adhere to these liners, thereby hindering the rotation of the disc.

Recently, artificial plastic media have been used in barrel finishing. This plastic medium is generally produced by externally heating, in a mold, a mixture of abrasive material and grains of bonding material of an unsaturated polyester resin, a polyvinyl chloride resin, etc. Through this external heating, if the entire mixture is sufficiently heated, a skin layer of the bonding material is formed on the outside of the medium. If on the other hand the mixture is heated such that only the outside of

the medium is heated, so as to prevent such a skin layer on the surface of the medium, the inner part of the medium will be brittle because the abrasive material and the bonding material have not been combined sufficiently. These resulting brittle media will cause fragments to appear during barrel finishing, and the fragments may be jammed in the slit of the barrel as described above.

Japanese Patent (Y) 2-43,652 discloses an improved plastic finishing medium which is, for example, in the shape of a cylinder. This medium is porous and has no skin layer on the outer surface. It contains abrasive grains combined with the bonding material and has pores between the abrasive grains. Since the abrasive grains are separated by pores and are always exposed, they are effective.

The present invention provides a dry barrel finishing machine equipped with an air suction device and a dust collector for causing air to flow through the barrel and remove the attrition dust produced during barrel finishing. The air flow also reduces the frictional heat evolution of the mass and the barrel.

The barrel may be a centrifugal type equipped with a rotary plate or a vibratory type equipped with a driver.

Using a medium which is porous and has no outer skin layer of bonding material is preferable for the purpose of dry barrel finishing.

In the accompanying drawings:-

Fig. 1 is a partially sectional front view of a first embodiment of a dry barrel finishing machine according to the present invention;

Fig. 2 is a plan view of the machine of Fig. 1;

Fig. 3 is a partially sectional front view of a medium for use in barrel finishing machines of this invention;

Fig. 4 is a front view of a second embodiment of a dry barrel finishing machine according to the present invention, in which a vibratory barrel is used;

Fig. 5 is a sectional view taken along the line V-V of Fig. 4;

Fig. 6 is a partially sectional front view of a third embodiment of a dry barrel finishing machine according to the present invention and having a vibratory barrel; and

Fig. 7 is a plan view of the machine of Fig. 6.

In Figs. 1 and 2, a dry barrel finishing machine has a centrifugal barrel 1. The barrel 1 is mounted between a pair of portal frames 2,2 which serve as a base for the barrel. The barrel 1 accommodates workpieces and finishing media and causes them to flow in it for the abrasive finishing of the workpieces. The barrel 1 includes a fixed cylindrical tank 4, a disc-shaped plate or dish 5 for supporting the tank 4, and a bottom rotary plate 9. A liner 3 is attached to the inner surface of the cylindrical tank

4. The supporting plate 5 is integrally mounted on a cylindrical boss 6. The rotary plate 9 is disposed above the supporting plate 5 and is fixed by fasteners, such as bolts, to a vertical shaft 8 which is positioned within the boss 6 and is mounted rotatably to the boss 6 via bearings 7,7 for the smooth rotation of the shaft 8.

As shown in Fig. 1, the circumferential edge and the upper surface of a part of the rotary plate 9 are covered by a liner 11 so that there is a circular slit 12 between the liner 11 on the edge of the rotary plate 9 and the liner 3 on the lower portion of the cylindrical tank 4. The width of the slit is so small that the media and workpieces cannot enter it. A space 10 between the supporting plate 5 and the bottom rotary plate 9 communicates through the slit 12 with a space above the rotary plate 9 so that air entraining any attrition dust can flow between the spaces.

A driving unit 20 is attached to the boss 6 and is operatively coupled to the vertical shaft 8 for rotating the bottom rotary plate 9 about the axis of the vertical shaft 8. The unit 20 includes, in this example, reduction gears 21 and a motor 22 for driving the reduction gears 21.

As clearly shown in Fig. 2, the supporting plate 5 at both sides (the top and the bottom in Fig. 2) is provided with a pair of arms 13, 13 which are connected to shafts 14, 14. The shafts 14, 14 are rotatably supported on bearings 15, 15 mounted on the frames 2, 2. Thus, the barrel 1 including the tank 4 and plates 5, 9, the boss 6, the vertical shaft 8 in the boss, and the driving unit 20 are supported by the frames 2, 2 through the shaft 14, 14.

A sprocket wheel 16 is attached to one of the shafts 14, 14. A motor 17 is mounted on the frames 2, 2 at a lower portion, and a sprocket wheel 18 is attached to the output shaft of the motor 17. A chain belt 19 is engaged with the wheels 16, 18. Thus, the motor 17 is operatively coupled to the barrel 1. Therefore, the barrel turns about the axis of the arms 13, 13 when the motor 17 operates.

An air suction device 23 is disposed under the supporting plate 5. The device 23 includes a suction hole 24 formed in the bottom portion of the supporting plate 5, and a flexible duct 25. One end of the flexible duct 25 is connected to the suction hole 24, and the other end is connected to a dust collector 26. The dust collector may be installed on the floor or any other suitable place and is connected to a vacuum source (not shown).

In Fig. 3, a finishing medium piece 30 is shown. This medium piece 30 is as disclosed in the above-mentioned Japanese Patent (Y) 2-43,652 and is suitable for use in dry barrel finishing machine according to the present invention. To produce the medium pieces 30, a mixture comprised of a certain amount of abrasive grains 30a and of

plastic grains 30b for bonding the abrasive grains 30a is dropped into a mold. The abrasive grains 30a may be ceramics containing any zirconium oxide grains, aluminum oxide grains, silicon carbide grains, titania grains, etc. of mesh size 60-1500. The plastic grains 30b may be selected from the group of a phenolic resin, urea resin, melamine resin, epoxy resin, etc., of which the dielectric loss factor (10 c/s - 10⁶ c/s) is more than 0.02. The mold may be, for example, made of a silicon gum, of which the dielectric loss factor (10 c/s - 10⁶ c/s) is more than 0.02. The mixture in the mold is then compressed. After compression, the mixture is heated for 0.5-3 minutes by a high-frequency heater so that the resin 30b is melted and the abrasive grains bonded completely. The medium piece 30 thus produced is porous because it contains small pores 30b which are evenly spread in the cylindrical body. Therefore, the medium piece is not covered with a skin layer of resin, and abrasive grains 30a are exposed. When the medium is rubbed against workpieces during the finishing operation, the abrasive grains 30a are always exposed.

Now, the operation of this dry barrel finishing machine will be explained. The barrel 1 is kept horizontal, and a suitable amount of workpieces and media are placed in the barrel. Then, the motor 22 of the driving unit 20 is operated to transmit the driving power through the reduction gears 21 and the vertical shaft 8, thereby causing the rotary plate 9 to rotate horizontally. The mass consisting of the media and the workpieces advances along the inner surface of the tank 4 by taking a spiral motion as shown by exemplary lines 29 in Fig. 1.

During the finishing process, the workpieces can be effectively finished since the abrasive grains 30a, which serve as effective blades, are always exposed when the media 30 pieces are worn. Since the vacuum source and dust collector 26 are activated during finishing, air above the tank 4 is caused to flow in the direction shown by 27 and through the circular slit 12, the space 10, and the duct 25 into the dust-collecting device 26. This air flow prevents the attrition dust produced during barrel finishing from spreading out upwardly from the tank 4. The attrition dust becomes entrained in the air and guided into the dust collector 26. The dust in the device 26 may be disposed of subsequently. This air flow, which passes through the tank 4, also serves to lower the frictional heat of the mass and the barrel caused during the abrasive finishing.

After the finishing is completed, motor 17 is operated to rotate the barrel 1 about the axis of the horizontal arms so that the mass in the barrel is discharged from the opening of the tank 4. The

barrel is then returned to the original position.

Although the machine does not require any cover for the tank 4, a simple tank cover having apertures in it may be provided, if desired. In any case, the top of the barrel must be open to air to cause an air flow in the barrel. In the embodiment shown in the drawings, the mass can be discharged easily from the top of the barrel. Further, since all elements for the operation of the barrel 1 are disposed in the frames 2, 2 thereunder, the machine can be compact.

In Figs. 4 and 5, another dry barrel finishing machine is shown. Fig. 4 is a front view of the machine taken along the line IV-IV of Fig. 5. The tub or barrel 31 of the machine has, for example, a U-shaped cross section of which the lower part is semicircular as shown in Fig. 5. The barrel 31 has a U-shaped wall 32 and side walls 33, 34 secured to the sides of the U-shaped wall 32. Alternatively, the tub may have a flat bottom. The barrel 31 is fixed to a table 35. The table 35 supporting the barrel 31 is elastically supported by a plurality of elastic members, for example, coil springs 37 which are in turn secured to a base 36. The inner surfaces of the barrel are covered by liners 38 as shown in Fig. 5.

A driver 41 is mounted between two upright hanging side walls 39, 40 of the table 35. The driver 41 includes cam means in the form of a rotary shaft 42 and a round bar 43 eccentrically fitted on the rotary shaft 42. The rotary shaft 42 is parallel to the longitudinal axis X-X of the barrel. The eccentric round bar 43 is rotatably mounted in holes formed in the hanging side walls 39, 40. One end of the rotary shaft 42 is connected to reduction gears 44, and a motor 45 is operatively coupled to the reduction gears 44. The rotary shaft 42 and the bar 43 are enclosed by a cylindrical cover 46.

When the motor 45 is operated to rotate the shaft 42, the eccentric round bar 43 rotates and pushes the upright side walls 39, 40 of the table 35 in all directions perpendicular to the axis of the shaft 42. Therefore, thanks to the coil springs 37, the table 35 moves or vibrates vertically and horizontally. This causes the mass in the barrel to flow as shown by an exemplary flow line 54, whereby dry finishing of the workpieces by the media 30 is effectively carried out.

Like the machine of the first embodiment described above, an air suction device 47 is also provided for this machine. At the bottom portion of the barrel 31, a plurality of small vents 48 are formed. A hood 49 is attached at one end to the bottom portion of the barrel to communicate with the interior of the barrel 1 through the vents 48. The other end of the hood 49 is connected to a duct 50 which is connected to a dust collector 51. The collector 51 communicates with a vacuum

source (not shown).

During barrel finishing, any attrition dust in the air is sucked by the vacuum source as shown by air flow lines 53. The air flow passing through the barrel lowers the frictional heat of the mass and the barrel as mentioned above.

When the finishing is completed, the mass is discharged from the barrel through a chute 52 attached to the side wall 33.

In Figs. 6 and 7, another embodiment of a dry barrel finishing machine according to the present invention is shown. The machine has an annular barrel 55. As shown in Fig. 6, the barrel 55 has a U-shaped wall 56. The bottom of the barrel may be round, as shown in Fig. 6, or flat. The barrel is mounted on a horizontal circular table 57. The table 57 is supported by a plurality of elastic members 59, for example, coil springs. A box-like base 58 for supporting the table 57 is disposed under the table 57. The elastic members are secured to the top portion of the base 58. The U-shaped inner wall surface of the barrel is covered with a liner 60.

As will be understood from Fig. 6, a driver 61 is suspended from the top portion of the base 58. The driver 61 is located at the central portion of the annular barrel 55. The driver 61 includes a motor 62 vertically mounted on the base 58. The motor 62 extends both upwards and downwards from the top portion of the base. The output shaft of the motor 62 also extends upwards and downwards. The motor includes a pair of counterweights 63, 64 attached to the upper and lower ends of the output shaft. The counterweights are designed so as to locate at vertically aligned positions. Since the rotation of the counterweights causes the top portion of the base to deflect and the elastic members to act, the barrel effectively vibrates.

An air suction device 65 is provided at the outer lower part of the barrel 55 as shown in Figs. 6 and 7 for the same purpose as those of the machines described relating to Figs. 1 and 2 and Figs. 4 and 5. Also, a plurality of small holes 66 are formed in the outer lower part of the barrel. The suction 65 is connected to a duct 68 through a hood 67. The duct is connected to a vacuum source (not shown) through a dust collector 69. In the example shown in the drawings, only one air suction device is provided. However, a plurality of air suction devices may be provided at some circumferential portions of the barrel so that the attrition dust can be more effectively caught and borne by the air. In this case, the air suction devices may be connected to one or more ducts which are connected to the dust collector.

As shown in Fig. 7, the barrel 55 is provided with a plate flapper 70. The flapper 70 is rotatably mounted on the barrel and is recedable therefrom when not used. The distal end of the flapper 70 is

put into the passage of the mass to take out the finished workpieces and the remaining media from the barrel. The flapper 70 serves as a guide for guiding the mass onto a screen 71 mounted on the barrel. The mass discharged from the barrel is separated on the screen 71 into the finished workpieces and the worn media.

The operation of the machine will now be explained. When the mass consisting of the media 30 and suitable workpieces are placed in the barrel 55 of the machine, the motor 61 and the vacuum source for the dust collector 69 are activated. As a result, the counterweights 63, 64 rotate. This causes the barrel 55 on the table 57 to move vertically and horizontally or swing by the action of the elastic members 59. Therefore, the mass flows in the barrel in directions shown by flow lines 73 while moving along the annular barrel. Thus, the workpieces are finished.

By the air suction device or suctions disposed under the barrel, the same effects can be obtained during finishing, as in the machines of Figs. 1 and 2 and Figs. 4 and 5.

When finishing is completed, the flapper 70 is rotated by a lever (not shown) so that the flapper is placed into the barrel. Therefore, the mass flowing along the annular barrel is carried on the flapper 70 and then onto the screen 71, where the mass is separated into the finished workpieces and the worn media. They may be further treated or processed. When the mass is discharged from the barrel, the motor 61 and the dust collector are stopped, and the flapper 70 is returned to its original position.

In the above embodiments, some drivers are used. It is, however, apparent to those skilled in the vibrating art that any other known mechanical, electrodynamic, or electromagnetic driver may be used.

Claims

1. A dry barrel finishing machine, comprising:
 - a base (2;36;58);
 - a barrel (1;31;55) mounted on the base for receiving a mass consisting of finishing media (30) and workpieces;
 - driving means (20;41;61) for causing the mass to flow in the barrel;
 - air suction means (23;47;65) connected to the barrel and arranged to cause air in the barrel to flow through the mass; and
 - a dust collector (26;51;69) connected to the air suction means for receiving air with attrition dust therein from the air suction means.
2. A machine as claimed in claim 1, wherein the said barrel includes:
 - a stationary hollow cylindrical tank (4), the inner surface of which is covered with a liner (3);
 - a supporting plate (5) mounted on the said base (2) for supporting said tank; and
 - a rotary plate (9) mounted on a vertical rotary shaft (8) on the said base so as to be located above and spaced apart from the said supporting plate, thereby forming a passage (10) for the air from the barrel to flow to the air suction device (23), the rotary plate being covered with a liner (11), a slit (12) being formed between the lower portion of the liner (3) on the inner wall of the tank and the edge of the liner (11) on the rotary plate, the said passage (10) communicating with the barrel through the slit.
3. A machine as claimed in claim 2, wherein the said driving means comprises a motor (22) mounted under the said supporting plate (5) for rotating the rotary plate (9) on the vertical shaft (8) to cause the mass to flow in the barrel.
4. A machine as claimed in claim 2 or 3, wherein the said air suction means (23) includes a suction hole (24) formed in the said supporting plate (5), the hole being open to the said passage (10), and a duct (25) connected at one end to the said hole and at the other end to the said dust collector (26).
5. A machine as claimed in any of claims 2 to 4, wherein the said supporting plate (5) is rotatably mounted on the base (2) so as to be turnable about a horizontal axis.
6. A machine as claimed in claim 1, wherein the said barrel (31;55) is formed as a U-shaped channel and is vibrantly supported on the said base (36;58) by means of a plurality of elastic members (37;59).
7. A machine as claimed in claim 6 or 7, wherein the said driving means include a driver (41;61) for causing the mass to flow in the barrel.
8. A machine as claimed in claim 6 or 7, wherein the said air suction means (47;65) includes a plurality of air-suction holes (48;66), a hood (49;67) covering the said holes, and a duct (50;68) connected to the said hood at one end and to the dust collector (51;69) at the other end.

9. A machine as claimed in claim 1, wherein the said barrel (55) is annular, and wherein the said driving means include a driver (61) causing the mass to flow in the barrel.

10. A dry barrel finishing machine, comprising:
a base (36);
a barrel (31) for receiving a mass consisting of workpieces and media, the barrel being open to the air at an upper part and having an air suction means (47) at a lower part thereof;
means (35,37) for supporting the barrel, the supporting means being mounted under the barrel and including a plurality of elastic members (37) mounted on the said base, the elastic members supporting the barrel such that the barrel can move reciprocally; and
cam means (42,43) mounted on the said supporting means for displacing the supporting means vertically and horizontally.

11. A method of dry barrel finishing, comprising the steps of:

charging into an open barrel a mass consisting of a predetermined amount of workpieces and finishing media, the media being produced by heating in a mold a mixture of abrasive grains and plastic grains by a high-frequency heater so as to combine the abrasive grains in such manner that each media has pores therein, but has on the outer surface no skin layer of the plastic;

causing the mass to flow in the barrel; and
sucking air into the open barrel while the mass is flowing so that air passes through the mass, thereby reducing frictional heat caused by the attrition of the mass and the barrel and discharging the air together with the attrition dust borne in the air.

12. A method as claimed in claim 11, wherein the air in the barrel is sucked from a lower part of the barrel.

FIG. 1

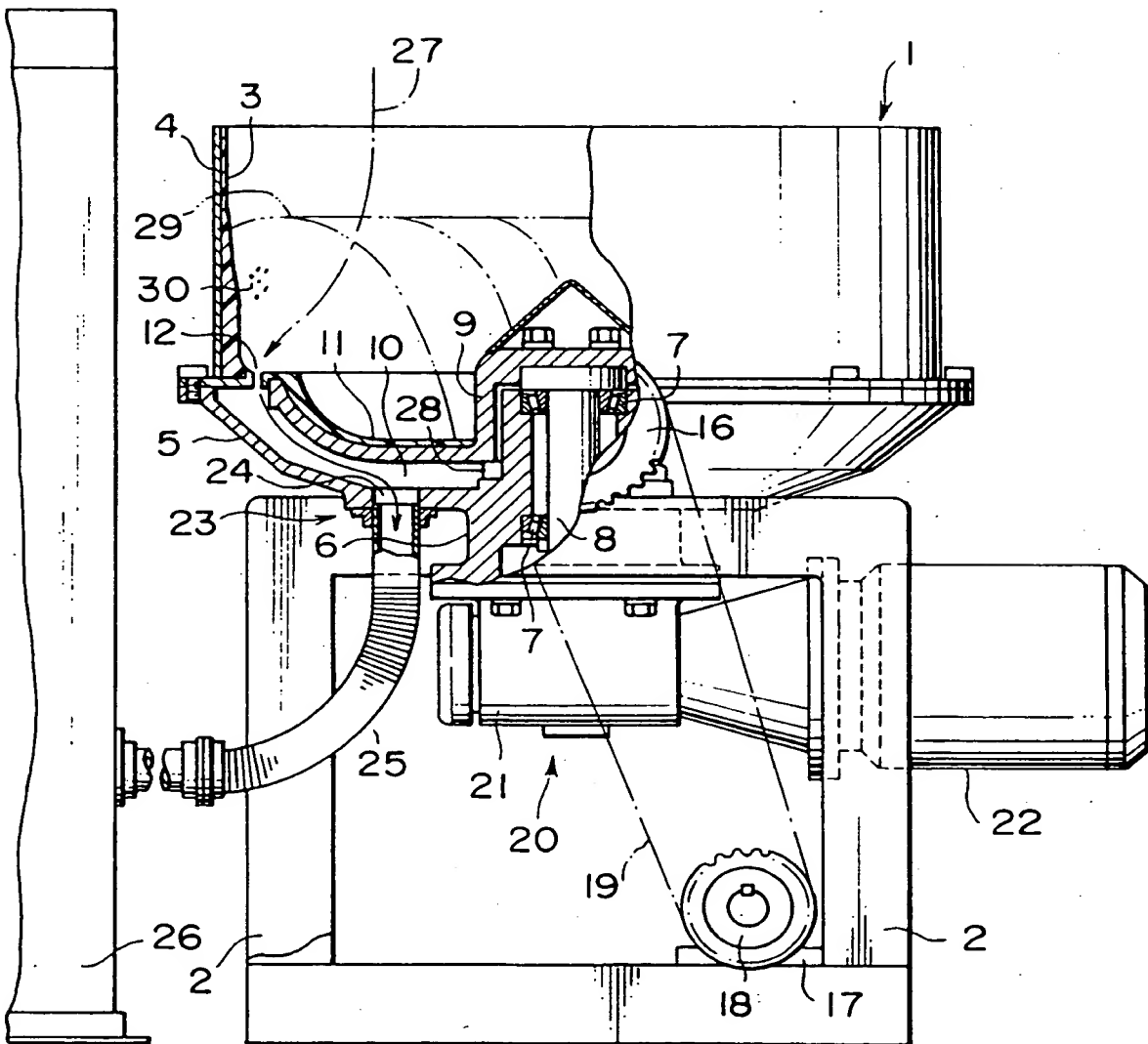


FIG. 2

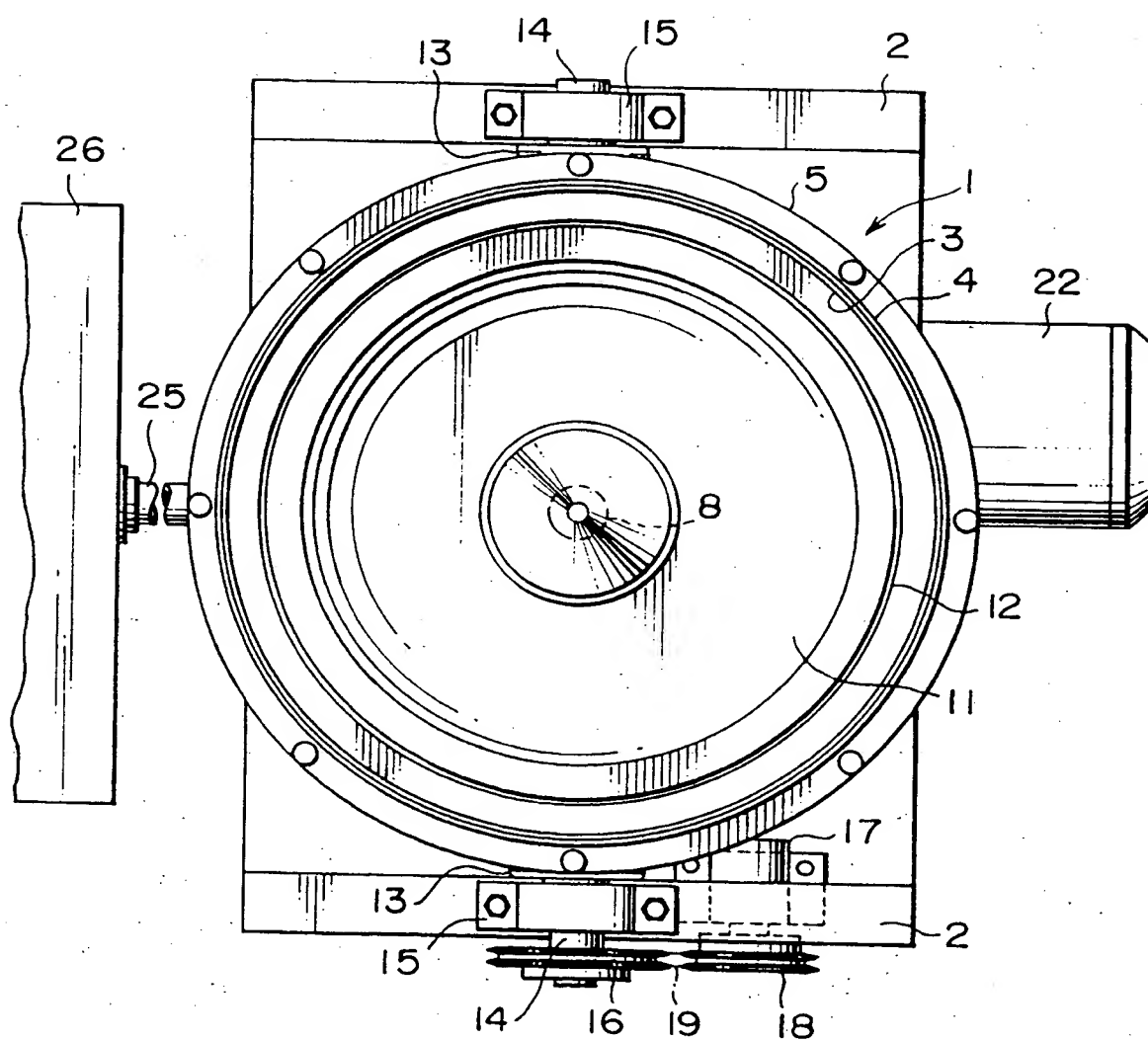


FIG. 3

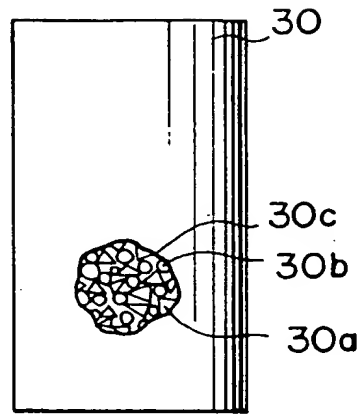


FIG. 4

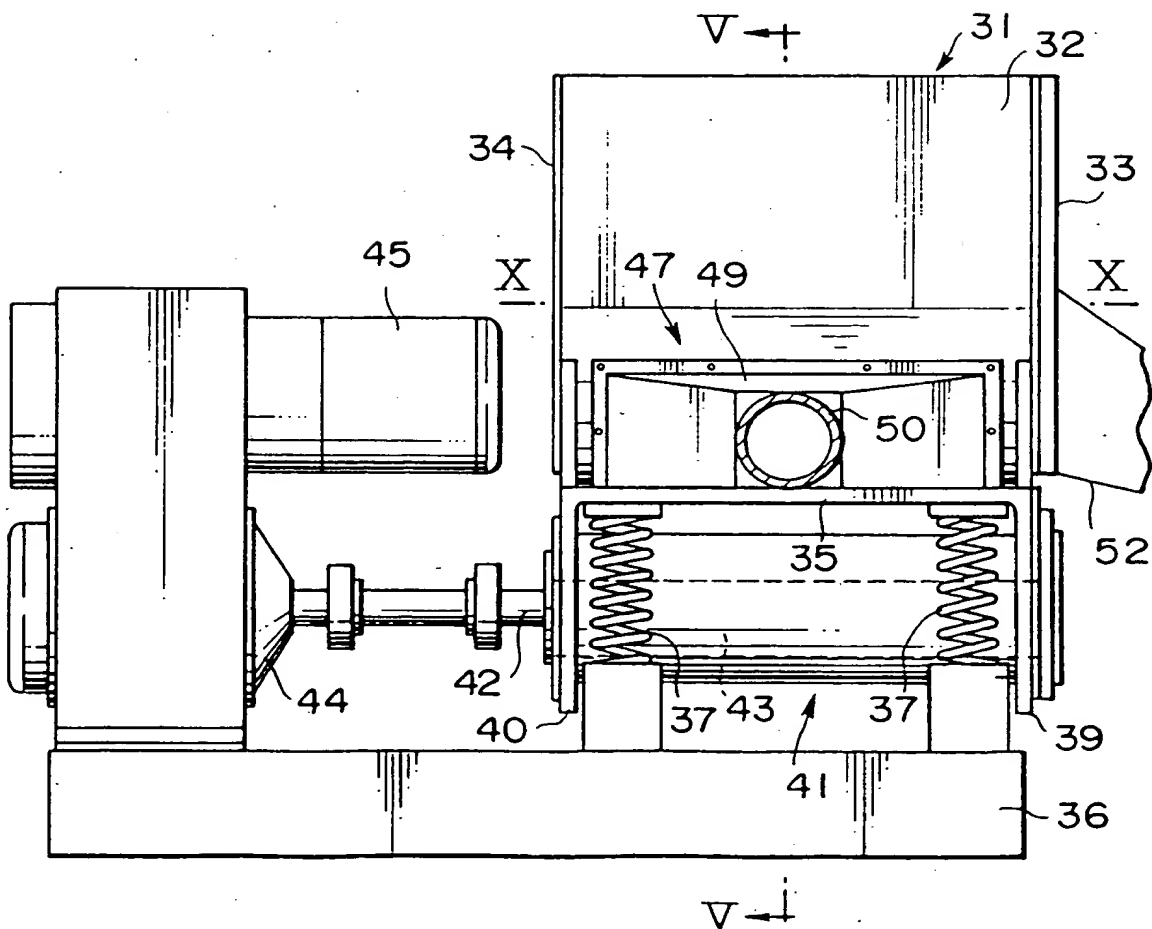
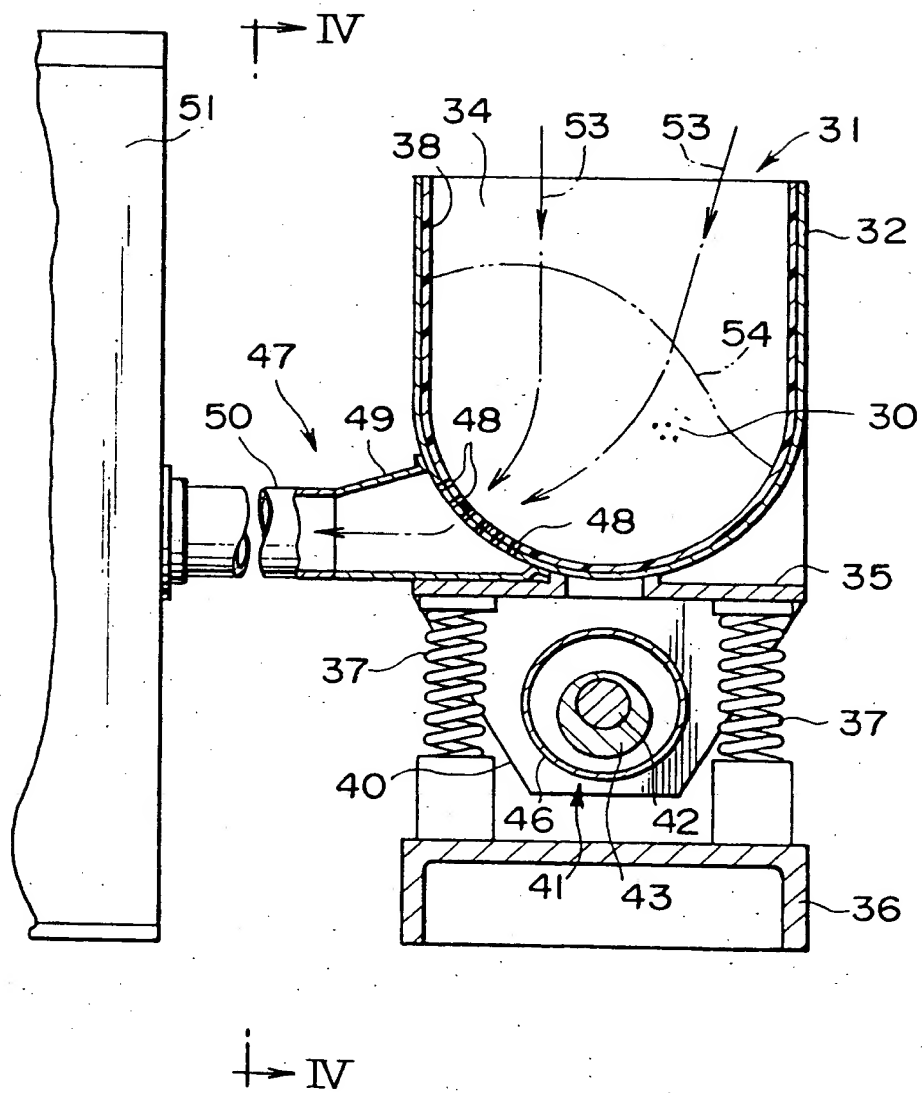


FIG. 5



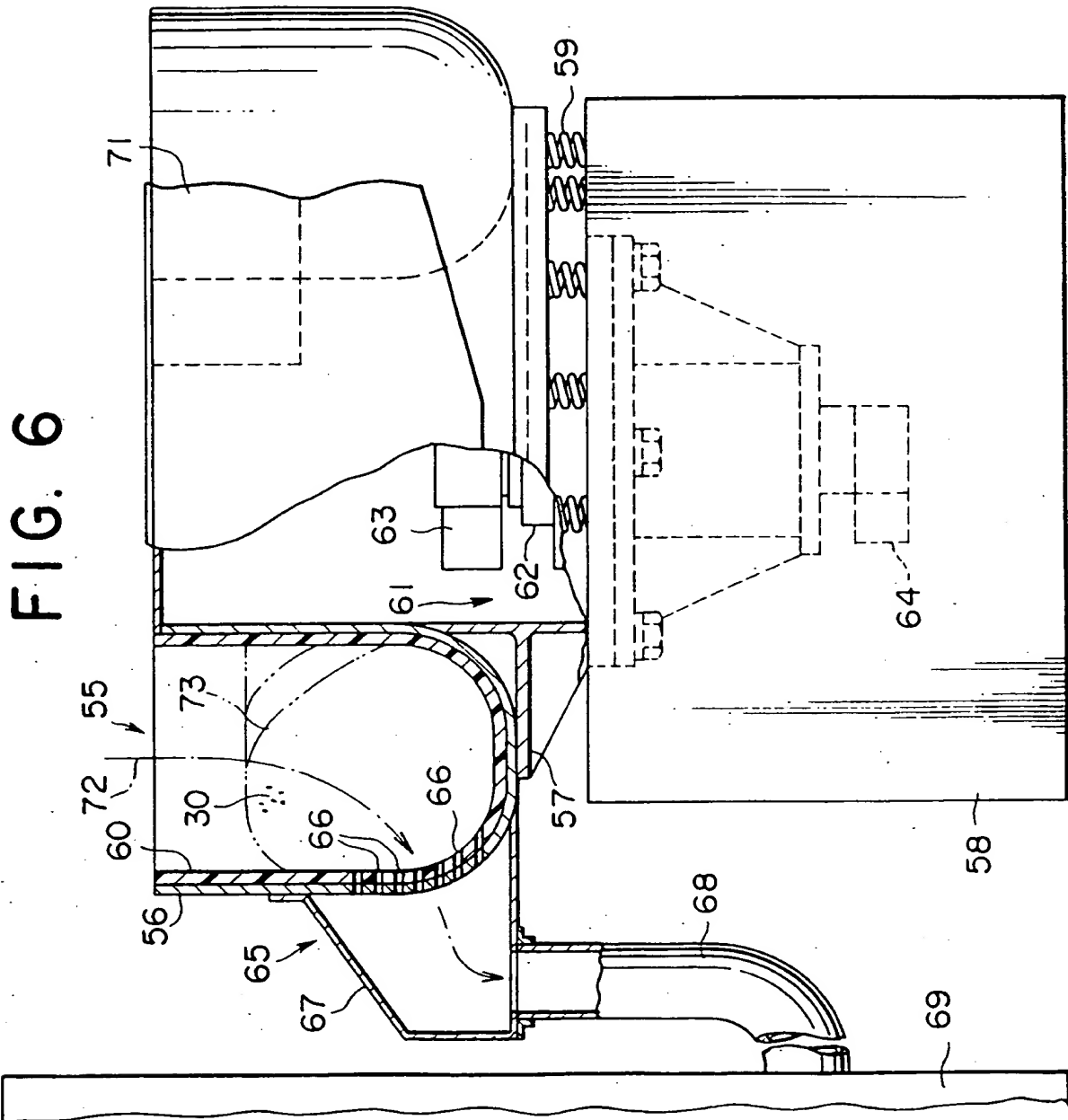
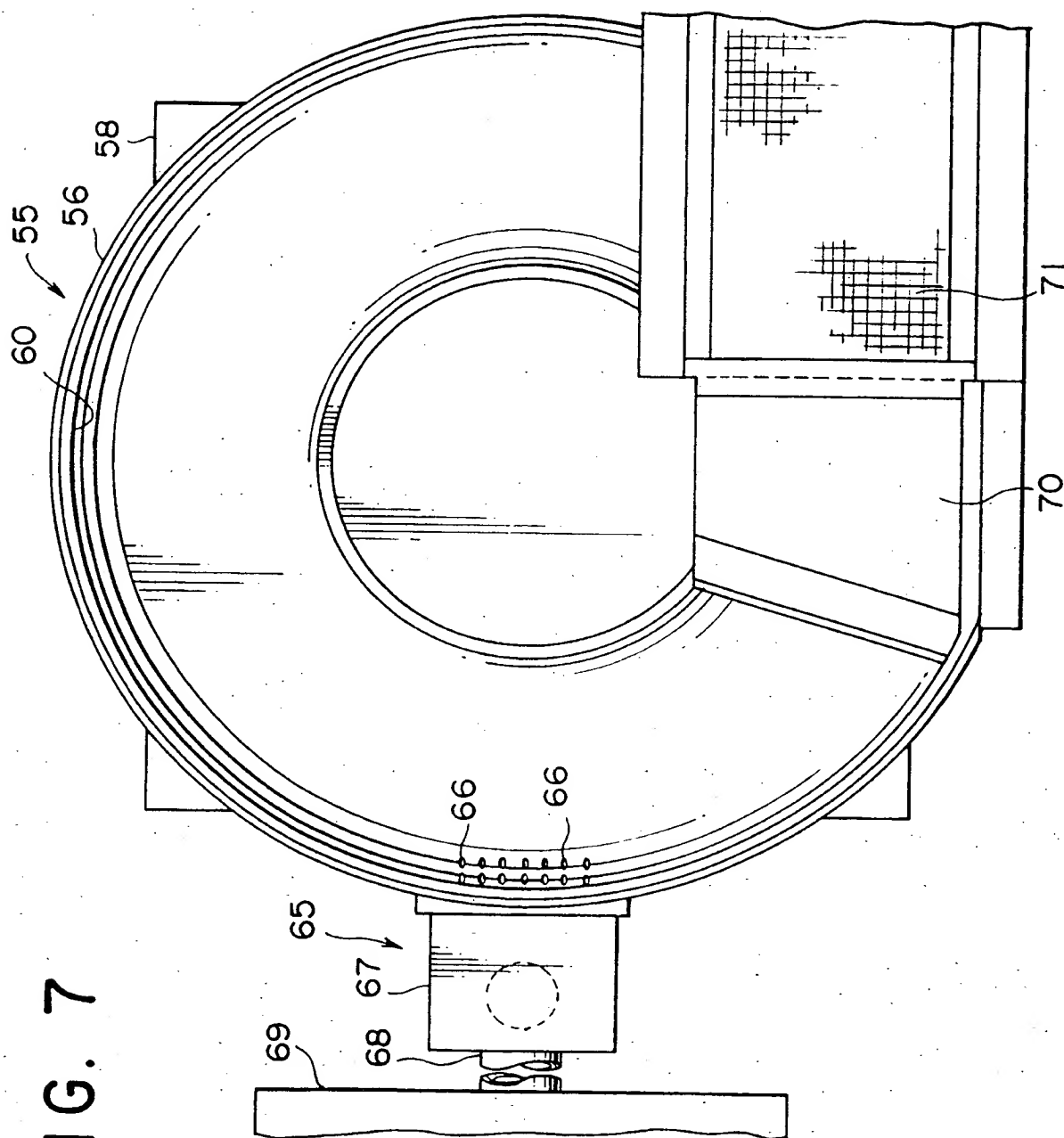


FIG. 7





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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 3201

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-A-36 23 869 (RÖSLER) * column 2, line 6 - line 12 * * column 3, line 55 - column 4, line 28; figures *	1,9,10	B24B31/12 B24B31/108
Y	---	2-8	
A	---	11,12	
Y	EP-A-0 487 946 (MAX SPALECK) * column 3, line 35 - column 4, line 3; figures *	2-4	
Y	---		
Y	DE-A-30 35 674 (MAX SPALECK) * page 7, line 11 - line 23 *	5	
Y	---		
Y	DE-A-38 11 680 (SANKI BRAST CO.) * column 2, line 44 - line 68; figure 1 *	6-8	
A	---		
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 465 (M-882) 20 October 1989 & JP-A-01 182 029 (ARON KASEI CO LTD) 19 July 1989 * abstract *	11	
A	---		
A	EP-A-0 523 624 (ROLLWASCH ITALIANA S.P.A.) * figure 3 *	11	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25 January 1995	Examiner Garella, M
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